

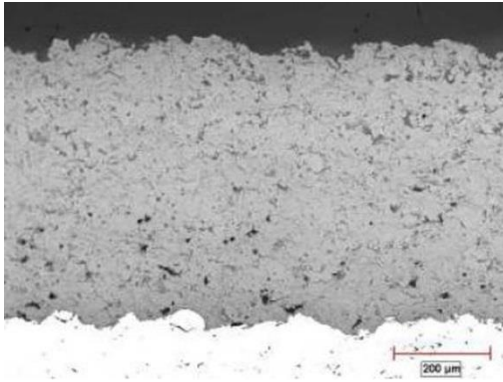
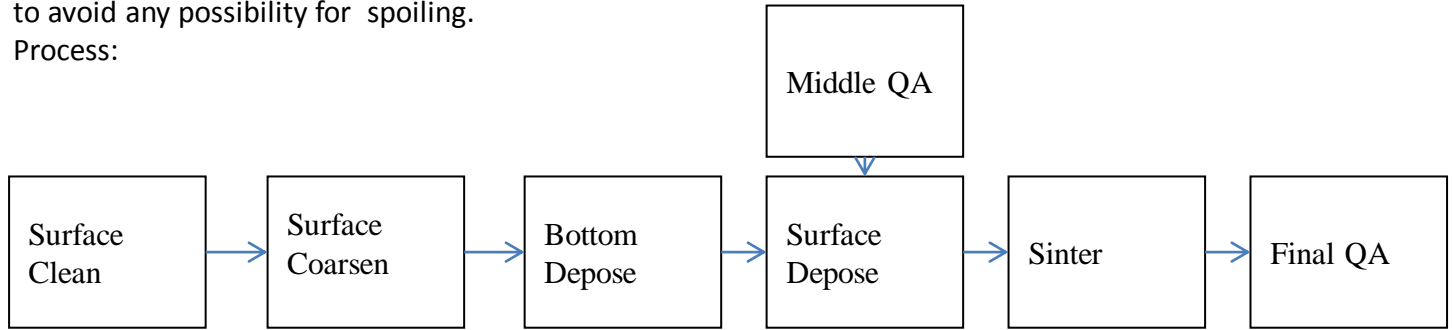
# Consumables for Glass Melting

HMT has a sub-team with many years of experience in designing and supplying various Electrodes, Electrode Protectors and Throat Protectors for glass furnaces.

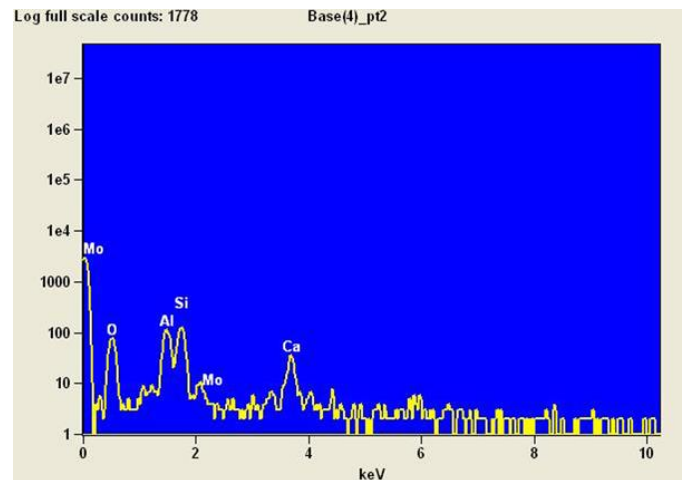
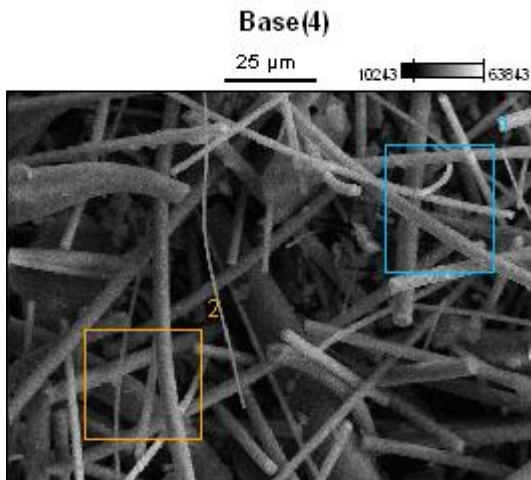
## 1, Surface-improved Anti-oxidation Mo Protector

Eroded and flushed by glass melts, dog-hole throats and boob bricks are worn out earlier than expected. To longer the service life for the throats and bricks, we have worked out a surface improving technique which refers to depositing an anti-oxidation layer on refractory materials, throat protectors and electrodes. The anti-oxidation materials to be clad on those parts are well chosen to make sure their compositions close to the glass concerned to avoid any possibility for spoiling.

Process:



The following graphs show the Aluminum Silicate Cotton (ASC) residue scraped from the peephole on the melting stove after heating to 1500 °C and no Mo volatile was found :



Weight %

	O-K	Al-K	Si-K	Ca-K	Mo-L
Base(4)_pt1	44.85	16.73	29.34	9.09	0.00
Base(4)_pt2	46.75	17.81	24.59	10.86	0.00

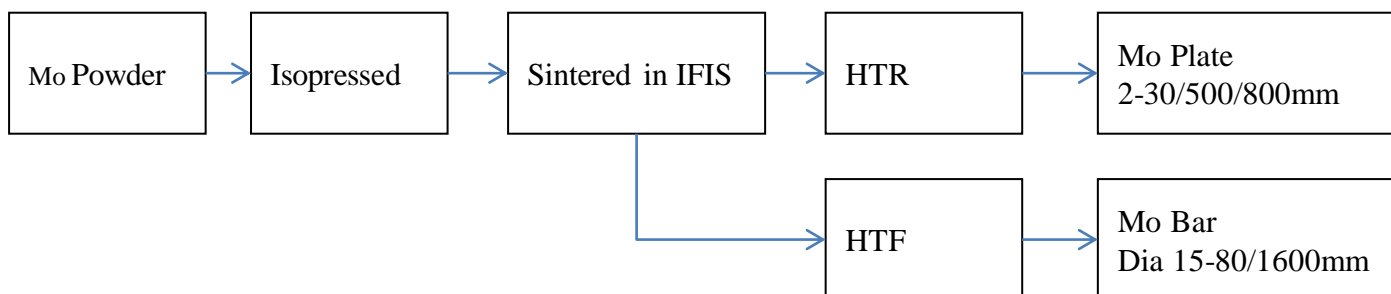
Atom %

	O-K	Al-K	Si-K	Ca-K	Mo-L
Base(4)_pt1	59.71	13.21	22.25	4.83	0.00
Base(4)_pt2	61.80	13.96	18.52	5.73	0.00

## 2, Electrodes

### a. Mo-La<sub>2</sub>O<sub>3</sub> Electrodes (Sintered)

The electrodes are made from Molybdenum (Mo) powder (160Mesh/FSSS  $\leq 2.8\mu\text{m}$ ) mixed with 0.2~2% Lanthanum (La). After Molybdenum Oxide (MoO<sub>3</sub>) is reduced through adding Lanthanum Nitrate (La(NO<sub>3</sub>)<sub>3</sub>), La is well distributed on the grain boundary of Mo powder so that Mo crystal's expansion under high temperatures is restrained thus the Mo electrodes becoming more high-temperature-resistant.



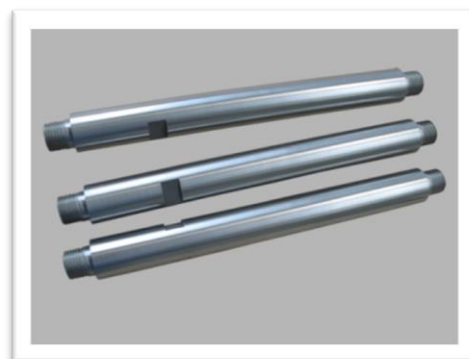
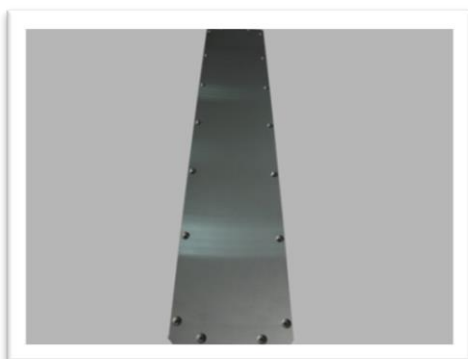
IFSI: Intermediate Frequency Inductive Stove

HTF: High-temperature Forged

HTR: High-temperature Rolled

### Specification

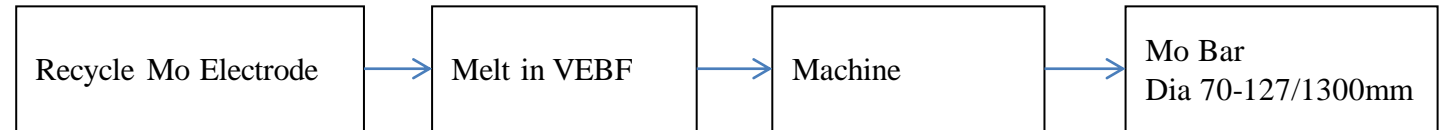
Specimen #	Al (w%)	Bi (w%)	Ca (w%)	Cd (w%)	Cr (w%)
001	<0.0001	<0.0001	<0.001	<0.001	0.0044
	Fe (w%)	Mg (w%)	Ni (w%)	P (w%)	Pb (w%)
	0.0092	<0.0001	0.0058	<0.001	<0.0001
	Sb (w%)	Si (w%)	Sn (w%)	C (w%)	N (w%)
	<0.0001	<0.001	<0.0001	0.0016	0.0022
	O (w%)	Mo (w%)	/	/	/
	0.0023	<99.96	/	/	/



### b. Pure Mo Electrodes (Vacuum Melted)

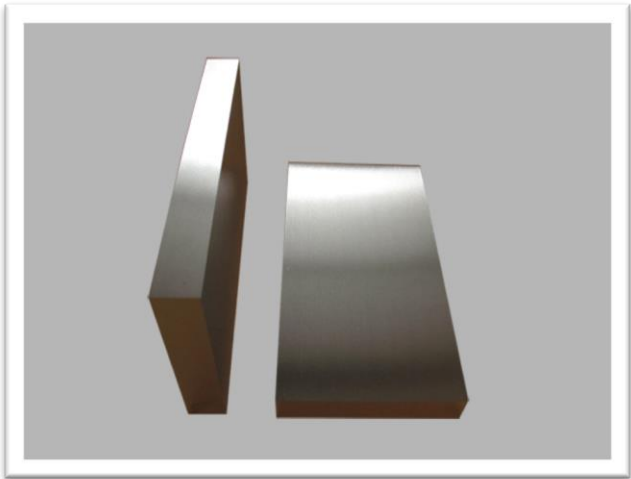
The electrodes are manufactured in a vacuum electron beam furnace (VEBF) at a temperature over 3600 °C and a vacuum as high as  $10^{-2}\text{Pa}$ . The high vapour pressure of MoO<sub>3</sub> and impurities, against the low vapour pressure of Mo, prerequisites the mass vapouring of the MoO<sub>3</sub> and the impurities thermo-dynamically. Furthermore, how long the vacuum melting lasts decides the extent to which the Mo melts contact with the vacuum, which dynamically paves the basis for the mass vapouring of the MoO<sub>3</sub> and impurities. Finally, center-inclined, compact and coarse bar crystals concrete bottom-up constantly from the bottom of the melting tank. Therefore, vacuum

melting does purify Mo, which is capable of achieving theoretical density of 10.2g/cm<sup>3</sup> for finished Mo electrodes. Vacuum-melt electrodes are superior to electrodes made by powder metallurgy since the latter, as a sintered solid, bear small crystal grains and big crystal boundaries. When the crystal boundaries reduce in toughness under a high temperature, the Mo electrodes' service lives fall down. In glass melting, the electrical currency born by a pure Mo electrode triples that by a Mo-La<sub>2</sub>O<sub>3</sub> electrode.



Specification

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	Fe (w%)	Mg (w%)	Ni (w%)	P (w%)	Pb (w%)
	0.0092	<0.0001	0.0058	<0.001	<0.0001
	Sb (w%)	Si (w%)	Sn (w%)	C (w%)	N (w%)
	<0.0001	<0.001	<0.0001	0.0016	0.0022
	O (w%)	Mo (w%)	/	/	/
	0.0023	≦99.96	/	/	/



**c. Dry (Air-cooled) Molybdenum (Mo) Electrode Kits**

After melted, homogenized and refined in the melting pool, glass liquids flow into a hopper. Through the cooling and adjusting sections of the hopper, the liquids are exposed to homogenous and stable temperature where they shape. Therefore, the performance of the electrodes configured inside the hopper is critical. Mo is the only material, which is electroconductive while insulating any other substance. No dry cell effect incurs between the glass liquid and the Mo electrodes because nothing else is conductive. Thus, no chemical bubbles form on the surface of the electrodes and in the liquids, which ensures the glass quality.



### 3, Water-cooled Electrode Jackets

#### a. Ordinary Jackets

We design and manufacture 3 kinds of customized jackets: side, bottom and top plug-in models. With their heads achieved by melting, forging and machining innovative nickel-based high-temperature alloys, our water jackets are capable of resisting ultra-high temperatures and thermo-shock and erosion thus ensuring the jackets endure as long as the service life of the furnace. So far, we have designed and supplied turn-key customized water jackets for 500 glass furnaces globally.



#### b. Special Jacket

We are proud to have designed a patent-pending Top Plug-in Jacket--a jacket with red copper as the lead body, capable of bearing a 2200A current. The jacket's head is delicately protected by ring-shaped Electrocast Zirco-aluminium Bricks (EZBs) from glass melts for 12 months. 12 months later when maintenance incurs, it just takes 10 minutes to replace the Mo half washer and EZBs. That saves all the trouble to separate the jacket from the Mo electrode.



#### HEADQUARTER:

Shanghai Xiang Rong Industrial Equipment Co. Ltd.

Phone:+86 21 3616 1907

Fax:+86 21 3616 0055

E-mail: [info@xr-ind.cn](mailto:info@xr-ind.cn)

<http://www.xr-ind.cn>

Add: #1-155th Lane Songbao Rd. Suite 613 Shanghai  
200940 PRC

#### FACTORY

Jiecheng Cramics Co. Ltd.-Xiang Rong Ceramics Co. Ltd.

Phone:+86 731 8708 2129

Fax:+86 731 2810 9323

Add.:North Xieyuan Rd. Ningxiang Economical &  
Development Park Changsha 410600 Hunan Province PRC

#### EUROPE BRANCH:

H.M.T. (Hard Materials Technologies) GmbH

Serge WEYDERT

Managing Director

Phone:+352 691 96 86 31

E-mail: [weydert.s@hmt-cera.com](mailto:weydert.s@hmt-cera.com)

<http://www.hmt-cera.com>

Add: 7 Rue Du Marche L-9260 Diekirch Luxembourg

